ACCELERATING INDIA'S FOOD GRAIN PRODUCTION

1967-68 TO 1970-71

REQUIREMENTS AND PROSPECTS
FOR A YEARLY GROWTH RATE
OF 5 PERCENT

FOREIGN AGRICULTURAL
ECONOMIC REPORT NO. 40

U.S. DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE

PREFACE

This report was first written for use by the U.S. Agency for International Development (AID) Mission to India in its program evaluation and planning during the summer of 1967. It was prepared in conjunction with papers on other subject matter areas, which together provided a comprehensive and fairly well-balanced analysis of India's agricultural production, potentials, and prospects. This report is presented essentially as first written, however, in the belief that both its substantive features and its methods of approach may be of interest to others concerned with the food problems of the world.

On the substantive side, this report indicates that India is on the move with respect to long needed improvements in agriculture, after having passed through the worst two consecutive drought years of this century. On the methodological side, it presents an approach to shortrun agricultural production projections of the kind frequently needed in international program operations which merits consideration for both its usefulness and its simplicity.

The authors are indebted to many people in the AID Mission to India as well as to persons in the Rockefeller Foundation, the Ford Foundation, the Ministry of Food and Agriculture of the Government of India, and other agencies for assistance in the preparation of this paper. The authors alone, however, bear full responsibility for choice of the data and information used in this report and for the interpretations that are made of them.

The Agency for International Development financed the research on which this report is based.

U.S. DEPARTMENT OF AGRICULTURE NEG. ERS 5419-67(11) ECONOMIC RESEARCH SERVICE

CONTENTS

Washington, D.C. March 1968

SUMMARY

This report deals with the potentials and requirements for increasing India's food grain production by 5 percent yearly from 1967-68 to 1970-71. It presents a model for projecting output by measuring the marginal product resulting from increases in farm inputs with response ratios based on tests and actual field cuts.

A 5-percent annual growth rate was chosen because it is near the minimal level needed to achieve self-sufficiency in food grain production within the next decade and it appears to be attainable and economically feasible. The year 1967-68 was chosen as a base since it holds promise as the turning point in India's agriculture.

The outlook for India's agriculture has greatly improved as a result of the introduction of new high-yielding grain varieties and sharply increased supplies of fertilizer and other farm inputs. These breakthroughs have occurred in only the past 3 or 4 years and come at a time when agriculture has been rocked by two consecutive years of drought--the most severe of the century. It is not coincidental that these advances were made in this period, for the importance of agriculture to India's economic progress has never been so dramatically illustrated as it was with the two poor grain crops of 1965-66 and 1966-67. This has led to increased emphasis upon policies and programs to accelerate expansion of agricultural output in India.

The key elements in India's improved agricultural base have been varietal breakthroughs for rice, wheat, maize, jowar, and bajra. These new high-yielding varieties are not only superior to native varieties under normal monsoon conditions but they greatly excel in their capacity for productively using fertilizer, water, and other inputs. These new grain varieties have been introduced in India in only the past 3 or 4 years and commercial adoption has expanded rapidly.

Fertilizer consumption in India has tripled in only 2 years as a result of increased imports and domestic production. This reflects changes in Government policies and programs for budget allocation, foreign investments, and particularly foreign exchange allocation.

Using estimates for the 1967-68 availabilities of high-yielding grain varieties, fertilizer, and irrigation, a model is developed which projects 1967-68 food grain production at 93.6 million tons which falls very near the level of the long-term annual trend of 2.7 percent. To reach an annual growth rate of 5 percent from 1967-68 to 1970-71 will require a substantial acceleration of the input base--fertilizer, pesticides, improved seed, and the like.

The model is used to find what base would be required to reach this growth objective in 1970-71. One base would include:

...121 million hectares sown to food grains

...38 million hectares irrigated for food grains

...13.2 million hectares sown with high-yielding varieties

...2.7 million tons of plant nutrients

These levels of inputs could be attained and, in fact, could be exceeded. So, the 5-percent growth objective is well within reach.

In the framework of the model is the assumption that the growth of India's agro-industry will be adequate to service the rising demands of agriculture. For example, farmers will need assured market outlets at incentive prices; marketing and storage facilities will need to be improved. It is recognized however, that there will inevitably be many day-to-day problems in this sector which must be solved for agriculture to successfully attain the desired rate of growth.

ACCELERATING INDIA'S FOOD GRAIN PRODUCTION 1967-68 to 1970-71

Requirements and Prospects for a Yearly Growth Rate of 5 Percent

by

William E. Hendrix, James J. Naive, and Warren E. Adams[1]

INTRODUCTION

This report deals with the potentials and requirements for increasing India's food grain production by 5 percent per year from 1967-68 to 1970.[2] It is composed of five major sections as follows:

...review of India's agricultural record since 1949-50,
...description of recent changes in technologies and policies providing a basis for accelerating growth,
...estimation model of 1967-68 food grain output,
...estimation of inputs and other requirements (within specified constraints) for a 5-percent growth rate, and
...review of current policies and programs bearing on the above requirements.

The year 1970-71 is the end of the fourth 5-year plan period. As such, it is the year toward which India's official targets on production, inputs, and other requirements are pointed.

The year 1967-68, instead of earlier years in the fourth plan period, is chosen as base for a yearly 5 percent takeoff in this report because
...1965-66 and 1966-67 were among the most severe drought years experienced by India in a century,
...1967-68 holds promise as a major turning point in India's food grain production potentials and in effectiveness of policies and programs for their realization.

Improvements made in India's agricultural base, particularly irrigation, since gaining independence in 1947 helped to cushion the adverse effects of the 1965-66 and 1966-67 droughts. Nonetheless, output dropped from 1964-65 to 1965-66 by the largest percentage for any year since 1920-21. The combined shortfall for 1965-66 and 1966-67 was larger than that for any other two consecutive years in this century.

These large production declines have provided dramatic illustration and created increased appreciation of agriculture's importance to India's general economic progress. This is reflected in greatly increased emphasis upon India's agriculture in the policies and programs of both Central and State governments, as well as of AID and other national and international development agencies.[3]

[1] William E. Hendrix, Agricultural Economist, Foreign Development and Trade Division, Economic Research Service, is in India engaged in research on factors associated with differences and changes in agricultural output and productivity. James J. Naive, Agricultural Economist, is with the Foreign Regional Analysis Division, Economic Research Service. Warren E. Adams was Economic Advisor to the Agricultural Division, AID Mission to India; he is now Professor of Economics, Earlham College, Richmond, Ind.

[2] The term "food grains" as used collectively in this report includes rice in milled equivalent and pulses. In contrast to most countries, in India grain is not generally used for livestock feed. In this report, "grain" will refer only to food grain. India's official food grain statistics are compiled on a crop-year basis which includes crops harvested during the 12-month period from July 1 of 1 year to June 30 of the following year. Thus, 1967-68 food grain production refers to those crops harvested in the last half of 1967 and the first half of 1968.

[3] India's government at the national level is commonly called the "Central Government" or simply "The Center" as is used later in this report.

Fortunately for the likely success of this new emphasis, it closely parallels large recent advances in adaptable farm technology in India which some believe have more to offer than all the other farm technological advances put together in the first half of this century. The key elements of these advances consist of varietal breakthroughs for India's major cereal crops--rice, wheat, jowar, bajra, and maize.[4] These hold promise of yield increases roughly comparable to that recently achieved for hybrid corn in the United States. The importance of such gains for India seems particularly great because of the large relative importance of cereals in total agricultural production.[5]

A food grain production growth rate of 5 percent per year has been chosen for the purposes of this analysis because:

...it is near the minimal level needed by India to achieve its own stated objective of self-sufficiency in grain production within the next decade,

...it appears to be attainable and economically feasible, assuming appropriate policies and programs for providing inputs, supporting facilities and services, and incentives.

From the side of needs, India must increase its grain production by 2.5 percent per year (some estimates run to 2.7 percent) just to feed its growing population at present per capita consumption levels and at the current level of self-sufficiency.

An additional increase of 1 percent or more per year is needed to meet increases in demand expected from rising per capita incomes.

Finally, an additional rate of increase in output is needed

...for progress toward India's stated goal of self-sufficiency in grain production;

...for replenishing now exhausted contingency stocks of grains, normally held by farmers, traders, and nonfarm households; and

...for building buffer stocks to stabilize market supplies and prices.

Fortunately, the rate of growth required to meet the last three needs turns upon India's own sense of urgency. For at least the next 3 to 5 years, India can effectively absorb as large an increase in food grain production as it can economically produce.

A 5-percent annual rate of growth from 1967-68 to 1970-71 would be a sharp upturn from historical rates of growth. It will meet the needs from population and per capita income growth and enable India to move toward its goal of grain and general economic self-sufficiency.

[4] Jowar is the Indian term for grain sorghum; bajra is spiked or pearl millet; and maize is corn.

[5] Food grains as used in this report account for about 75 percent of India's gross agricultural production. For an excellent report on Indian agriculture, see (13).

Underscored numbers in parentheses refer to references at the end of this report.

FOOD GRAIN PRODUCTION TRENDS

Output

India's progress in increasing food grains since independence has fallen short of its goals and needs. It is instructive, however, to look at its record:

...in context of the political, social, and economic problems that India as a new nation has faced; and

...against progress prior to Independence.

India's main problem since Independence has been that of integrating under a new, democratic nation a population--

...larger than that of the whole western hemisphere; larger also than that of all of Europe outside the USSR;

...more improverished and illiterate than that of any but a few relatively small Asian and African countries;

...more diverse in ethnic features, languages, religions, and political ideologies than is that of the whole population of Europe.

Even so, India's grain production record since independence looks good compared with that of the preceding half century. The production record in the first half of the 20th century for the area now comprising both India and Pakistan is as follows (21):

Time Period	Annual Average
	(Million tons)
1900-01 to 1909-10	67.6
1910-11 to 1919-20	72.7
1920-21 to 1929-30	68.1
1930-31 to 1939-40	67.8
1940-41 to 1947-48	67.4

In contrast, from 1949-50 to 1964-65, India as now constituted increased its food grain production by an average of nearly 2 million metric tons per year (table 1).[6]

[6] Unless noted otherwise, tons are metric.

Table 1.--India: Food grain production, 1949-50 to 1966-67 and "Trend" estimates of production, 1967-68

Year	Actual output	Moving averages of output, 1949-1950 to 1964-65--	
		3-year	5-year
	----------------Thousand metric tons----------------		
1949-50.........	60,653	--	--
1950-51.........	54,922	57,028	--
1951-52.........	55,508	57,368	60,988
1952-53.........	61,673	63,122	62,979
1953-54.........	72,186	68,155	65,838
1954-55.........	70,606	70,669	69,204
1955-56.........	69,216	70,720	70,170
1956-57.........	72,337	69,352	71,470
1957-58.........	66,504	72,509	72,689
1958-59.........	78,687	73,963	75,249
1959-60.........	76,699	79,135	77,323
1960-61.........	82,018	80,474	79,712
1961-62.........	82,706	81,057	80,023
1962-63.........	78,448	80,466	82,482
1963-64.........	80,243	82,562	--
1964-65.........	88,996	--	--
1965-66.........	72,030	--	--
1966-67.........	75,049	--	--
1967-68 trend estimate[1].....	--	[2] 95,730	[3] 93,940

[1] Omits use of 1965-66 and 1966-67 data.
[2] Using 1957-58 as "Origin" for computational purposes, $Y = 72416 (1.0283)^t$ where Y = output, and t = time in years.
[3] With 1957-58 as "Origin", $Y = 72038 (1.0269)^t$.

Source: (9).

Calculated on the basis of its annual output series, unadjusted for weather and associated yield variations, India had an output growth rate of 2.98 percent (compound) per year. Using moving averages to smooth out irregularities caused by weather, it had a growth rate of 2.83 percent using a 3-year average and 2.69 using a 5-year average. Projecting 1967-68 output at trend growth rates of 2.83 and 2.69 percent indicates an output of 95.7 million and 93.9 million tons, respectively.

Neither the 3-year nor the 5-year moving averages show a marked slowdown in the grain growth rate between the first and second half of the 1949-50 to 1964-65 period, such as is indicated from use of the unadjusted output data. The 5-year moving average indicates consistent year-to-year increases and a nearly imperceptible decline in rate of growth. Even for such decline as is indicated, one cannot be wholly sure whether it reflects a genuine shift in trend or is only the result of using a period of time too short for even a 5-year moving average to smooth out the influence of weather fluctuations that are quite normal to India.

Large shortfalls in production in 1965-66 and 1966-67 resulting from highly abnormal weather have focused world attention on India's food problem and created the impression that India's agriculture is nearly stagnant while its population is increasing by 2.5 percent or more per year.

India's agriculture has always been subject to large year-to-year variations in output as a result of the variable and uncertain monsoon rains upon which it depends. It has experienced severe famine extending over large parts of one or more of its major regions many times in its history. Twenty-seven famines, each extending over areas equal in size to one or more States such as Gujarat and Orissa, occurred in the 19th century. Many of India's droughts before 1900, however, resulted in famine, largely because of poor transport and communication facilities and lack of administrative machinery for procurement and distribution from surplus to deficit areas.

Since 1900, famines have occurred less frequently. India has, however, experienced an annual drop of 10 percent or more in its grain production five times since 1900. These years and the associated percentage declines in output were as follows (21):

Year	Percent
1907-08	12.9
1918-19	32.3
1920-21	24.0
1923-24	16.6
1965-66	18.8

Since 1923-24, famine or near-famine conditions resulting from drought have occurred much less frequently than between 1900 and 1923-24. However, frequent declines in output of less than 10 percent per year have continued to characterize Indian agriculture. In the 15-year period between 1949-50 and 1964-65, the following six declines occurred (in thousand metric tons):

From 1949-50 to 1950-51	5,731
From 1953-54 to 1954-55	1,580
From 1954-55 to 1955-56	390
From 1956-57 to 1957-58	5,833
From 1958-59 to 1959-60	1,988
From 1961-62 to 1962-63	4,262
Total	19,784

From 1964-65 to 1965-66, India's grain production dropped by 16,732,000 tons as a result of widespread drought. This was a shortfall equal to 85 percent of the sum of the above six annual declines occurring between 1949-50 and 1964-65. Worse still, this was followed by a second severe drought in 1966-67 in Bihar, eastern Uttar Pradesh, large parts of Madhya Pradesh, and parts of other States, most of which have dense populations and normally productive land.

That the recurrence of severe drought and near-famine conditions in 1965-66 and again in 1966-67 is the prelude to a new weather cycle and production declines of the frequency and magnitude experienced between 1800 and 1923-24 is highly doubtful--if for no other reason than that India now has chose to 40 million hectares of land under irrigation.

But whatever the frequency of droughts like that of 1965-66, even mere year-to-year output fluctuations of the frequency and extent of those between 1949-50 and 1964-65 make it difficult to obtain a statistically reliable estimate of India's rate of growth in food grain production from observations covering only 5 to 6 years such as from 1958-59 to 1963-64. Even for periods of 15 to 20 years, one needs to take careful account of yearly fluctuations caused by weather. This is attempted in this report by the use of 3-year and 5-year moving averages.

However for 1965-66 output, even a 5-year moving average differs substantially from the trend of earlier years or a 1965-66 projection based upon available inputs and normal output response ratios.

Data on output by States indicate that a few States had a larger output in 1966-67 than in 1964-65, notwithstanding somewhat less favorable weather in 1966-67 (tables 8 and 9).

Inputs

Inputs of land, irrigation water, labor, and fertilizers used in India's agriculture have been increasing rather steadily since 1950-51 (table 2). Gross sown area, however, only increased from 156.1 million hectares in 1961-62 to 157.9 million hectares in 1964-65. However, from 1960-61 to 1961-62, it increased by 3.4 million hectares after two earlier years of very little change.

Compensation for this slowdown in area growth, however, has been provided in large part by increases in irrigation, fertilizers, and other inputs. From 1952-53 to 1964-65, total fertilizer consumption in terms of plant nutrients increased tenfold, or by 586,880 tons. This is an amount sufficient to yield an increase in food grain output of 3.8 million tons, assuming a response ratio of 6.5. This output would equal that from about 5 million hectares of land at average yield levels. Fertilizer consumption in 1967-68 is expected to reach 2.1 million tons, enough over the 1964-65 level to yield an output equal to what might be expected from the addition of 16 million hectares of land. Nitrogen

Table 2.--India: Major agricultural inputs, 1950-51 to 1967-68[1]

Year	Major inputs			
	Land[2]	Water[3]	Labor[4]	Fertilizer[5]
	Thousand hectares	Thousand hectares	Thousand agr. workers	Metric tons
1950-51................	131,893	22,563	102,929	---
1951-52................	133,234	23,180	103,217	---
1952-53................	137,675	23,305	103,506	65,685
1953-54................	142,480	24,363	103,796	104,803
1954-55................	144,083	24,948	104,087	120,934
1955-56................	147,311	24,642	104,429	130,777
1956-57................	149,492	25,707	104,789	153,719
1957-58................	145,832	26,628	105,149	183,727
1958-59................	151,629	26,948	105,509	223,844
1959-60................	152,824	27,413	105,869	304,598
1960-61................	152,716	27,886	106,186	293,871
1961-62................	156,099	28,373	106,505	383,450
1962-63................	156,736	29,452	106,824	477,921
1963-64................	156,970	30,380	107,144	574,220
1964-65................	157,940	31,170	107,465	652,565
1965-66 (estimate).....	---	---	---	757,287
1966-67 (estimate).....	---	---	---	1,320,000
1967-68 (estimate).....	---	---	---	2,250,000

[1] Includes inputs used on other crops as well as on food grains.
[2] Gross sown area.
[3] Gross irrigated area.
[4] Agricultural workers as reported in National Income Account reports for selected years and estimated for intervening years using rates of change indicated in National Income Accounts Statistics.
[5] Tons of plant nutrients (N, P_2O_5, and K_2O).

Source: (2), (8), and (10).

consumption alone in 1967-68 will reach the total attained in the United States in the early 1950's.[7]

Multiple-cropping is an additional way of extending the effective land area. At present, only one crop per year is raised on 85 percent of India's net sown area. Much of the double-cropping is done on unirrigated land. Only about 15 percent of the net irrigated area is being used for 2 or more crops per year. With assured supplies of water the year round, two to three crops per year can easily be grown under Indian climatic conditions.

[7] The total cropped area in India, which takes into account multiple-cropping (land producing more than 1 crop per year), is approximately equal to that in the United States. Thus comparison of total nitrogen consumption for the two countries is valid.

Directions of Policies and Programs

In early efforts to modernize India's agriculture following independence, it was widely assumed that the technology for doing so was readily available; these efforts consisted of applying:

...indigenous techniques already employed by the better farmers, and

...importable technologies originally developed for farmers of economically advanced nations.

Emphasis in these earlier efforts, therefore, centered heavily upon building new institutions to facilitate adoption of known technologies rather than upon strengthening technological bases. These included:

...extension activities built around widespread use of village-level workers and community development programs,

...cooperatives to provide credit, and to distribute fertilizers, seeds, and other supplies,

...land reform to provide incentives to India's millions of tenants to adopt better methods, which under existing tenurial arrangements, would increase output but not their income.

Such price policies as were in effect before the 1960's were directed more to consumer interests than to larger incentives and smaller price risks for producers. Terms of trade (prices) between food grains and nonagricultural commodities therefore shifted through most of the 1950's in favor of the latter, to the detriment of farmers and agriculture as an industry.

The foregoing policies among States and smaller areas of India have met with varying degrees of success within the limits of available technologies. Agricultural output in Punjab (as constituted in 1965), Gujarat, and Madras increased from 1952-53 to 1964-65 by a compound rate of more than 4 percent per year (table 11). In four districts in the Punjab and two in Madras State, agricultural production increased on average more than 7 percent per year.

These high rates of growth reflected the presence of determined agricultural leadership which was above average in initiative, decision-making, and administrative experience. This leadership has been successful in assisting farmers in these areas to obtain more fertilizers, more irrigation facilities, and more technical assistance. Such leadership often is found in areas where the spirit of enterprise and entrepreneurial abilities are most widely developed. Some observers have noted that in India's more rapidly developing States, agriculture has been organized in large part around owner-operator freeholds, in contrast to large land-holding estates such as are found in the slow-growth State of Uttar Pradesh.

RECENT IMPROVEMENT IN FOOD GRAIN PRODUCTION POTENTIALS

The achievement of a 5-percent annual growth rate in national food grain production requires increasing the rate throughout most of India to the levels that a few States and, in particular, a few districts within these States have demonstrated is technically possible. The basis for doing this has been greatly improved as a result of recent developments in the following two important aspects of the Nation's agricultural economy: (1) Applicable farm technology and (2) policies and programs of both Central and State governments directed to the adoption of technological improvements.

Technological Advances

The key element in India's recent farm technological advance consists of highly productive varietal breakthroughs for rice, wheat, maize, jowar, and bajra. Supplies of new high-yielding varieties are large enough to insure relatively large increases in 1967-68 plantings.

A somewhat comparable technical advance in U.S. agriculture was the development and commercial adoption of high-yielding hybrid corn. After these were first successfully adopted in the Corn Belt in the 1930's, however, it took more than another decade of further research in other regions to develop hybrids well adapted to their soil and climatic conditions. In the United States, similar varietal advances for wheat, grain sorghums, and other cereals came several years later.

In contrast to the U.S. case, new highly productive varieties of rice, wheat, maize, jowar, and bajra have all come into commercial use in India within only the last 3 to 4 years, as a result of the transferability of varieties produced elsewhere and of India's own research.

Before turning to available information on yields and other attributes of these new varieties, brief reference to India's traditional crop varieties will help to set these varietal breakthroughs in their proper perspective.

India's traditional crop varieties have evolved over centuries as the surviving species in a harsh physical environment. This environment has been marked by frequent extremes of droughts and floods, uncertain and widely varying moisture conditions, low soil fertility, and crude tillage practices plus other complex crop production and soil management problems characterizing tropical and semitropical regions.

The crop varieties that have evolved out of this harsh environment have been well adapted to it, especially in terms of survival capacities. Except under such extreme drought as that which recently occurred in Bihar, they have usually yielded a crop of some size when imported varieties have failed. They have, in other words, demonstrated a capacity for withstanding large variations in soil moisture and associated intake of plant nutrients without correspondingly large variations in yields. These have been exceedingly important qualities, contributing for centuries to the survival of Indian farm people.

On the other hand, the very genetic features that have enable these varieties to serve the needs of Indian agriculture so well in the past, lower their response to fertilizers, water, and other inputs. Indigenous varieties have shown relatively low response and capacity to absorb such inputs within economically profitable limits.

Moreover, until recently, even the improved varieties developed in temperate climatic zones have shown little adaptability to tropical and semitropical conditions or to latitudes other than those for which they were developed. One reason for this is their high sensitivity to variations in length of day and sunlight intensity. Hence, in countries like India, available crop varieties have functioned as severe constraints to increasing agricultural output except at costs much higher than those required for comparable output increases in the United States.

In the case of wheat, new high-yielding varieties whose genetic features make them insensitive to variations in sunlight and therefore easily adaptable within wide latitudinal ranges have recently been developed. Paralleling this work, there has been much effort under leadership of India's scientists, working closely with those of other nations, to develop hybrids well adapted to India.

These new varieties are not only superior to traditional varieties under normal monsoon conditions but they greatly excel local varieties in their capacity for using fertilizer, water, and other inputs. In fact, larger inputs of fertilizers and plant protection materials together with assured supplies of water cannot be overemphasized as essential to the continuing success of the high-yielding varieties. Expressed in another way, the new high-yielding varieties involve more than the mere substitution of one kind of seed for another. Their successful introduction will require changes in nearly all components of Indian food grain production technology.

Rice.--Turning to specific varietal introductions, one rice variety now in fairly large-scale commercial production is ADT-27, which was developed in Madras State. In 1965, an average paddy yield of 3,820 pounds per acre was obtained on about 3,000 acres of ADT-27 grown under farm conditions in Tanjore District in the State of Madras. Yields ranged from 1,600 to 5,500 pounds with the top decile of growers having an average yield of 5,140 pounds and the lowest decile an average of 2,480. In 1966, under less favorable weather conditions and with the crop area increased to about 125,000 acres, the average yield of ADT-27 was 2,450 pounds. This was very favorable, compared with 1,760 pounds for "other improved varieties." Fertilizer use in the 1966 field trials was as follows:

Rice variety	Percentage of fields fertilized	Pounds of plant food per acre	
		Fields fertilized	All fields
ADT-27	97	68	64
Other Improved Varieties	80	47	37
Common Indigenous	75	37	28
Mixtures	55	29	16

Fertilizer yield responses for ADT-27 were somewhat low in 1966, probably because of unfavorable weather. But even then at up to 50 pounds of fertilizer per acre there was a response ratio of slightly over 28 to 1. The results were as follows.

Plant food (Pounds/acre)		Percentage of fields	Paddy yield
Group	Average	Percent	Pounds/Acre
0	0	3	1320
Under 50	33	38	2250
50-70	60	14	2400
70-90	80	23	2550
90-100	100	11	2810
110 & over	140	11	3080
Average	64	100	2450

Results of rice variety trials conducted in the 1966 kharif[8] season under auspices of the Indian Council of Agricultural Research with the Rockefeller Foundation cooperating are shown in table 3 for two levels of nitrogen application. In these trials, conducted in all areas of India, local Indica varieties not only had appreciably lower yields than did new Dwarf Indica and Ponlai varieties, but also demonstrated an appreciably lower response to fertilizers. In applications of nitrogen up to 50 kilograms per hectare, the response of improved varieties exceeded that of local varieties by more than 10 units of grain per unit of fertilizer used. This suggests a total response ratio of more than 20 to 1 for the improved varieties, for this range of nitrogen application.

[8] Fall and winter harvest season.

Table 3.--India: Summary of yields of specified rice varieties in the uniform variety trials, kharif 1966

Variety and type	Locations reporting	Yields of grain with nitrogen applied at--		
		50 kg/ha	100 kg/ha	Difference
	Number	Kg/ha	Kg/ha	Kg/ha
Dwarf Indica:				
TN-1 X Taichung 67.....	14	3,885	4,351	466
Taichung Native 1......	20	3,603	4,319	716
Dee-Geo-Woo-Gen........	15	3,644	3,899	255
IR 9-60................	17	3,445	3,857	412
Ponlai:				
Kaohsiung 68...........	19	3,729	4,198	469
Tainan 3...............	20	3,577	4,155	578
Chianung 242...........	20	3,344	3,947	603
Taichung 65............	18	3,543	3,884	341
Ch. 242 X CI 9155......	17	3,128	3,479	351
Local Indica:				
NC 1626................	14	2,893	3,200	307
Co 29..................	14	2,884	3,167	283

Source: (14).

Wheat[9].--Preliminary releases by personnel working on the Intensive Agricultural District Program, the Farm Management Group, Ford Foundation, reveal the following results on wheat yields for the 1966-67 crop in Ludhiana District in Punjab State:

Variety and year		Yield (Lb./A.)
Mexican	1966-67	4,200
Indian	1966-67	2,130
All Varieties	1965-66	1,970
All Varieties	1964-65	2,015

It is estimated that Ludhiana had 37,000 acres of the Mexican dwarf wheat varieties in 1966-67, constituting 11 percent of its total wheat area. This was probably grown by better farmers, which partially accounts for a yield nearly twice as large as that obtained for Indian varieties. Yields of Indian varieties during the 3 seasons since 1963-64 have varied little. All of the farmers growing Mexican wheat used nitrogen fertilizers and 73 percent used phosphate in addition; the average applications were 84.5 pounds of N and 23.3 pounds of P_2O_5 per acre. The average application for all wheat (including Mexican) in the district was 53.6 pounds of N and 11.9 pounds of P_2O_5 per acre. Fertilizer use for the Mexican varieties exceeded that for the Indian varieties by about 48 pounds per acre; average yield of the Mexican wheat was 2,070 pounds higher. Thus the Mexican varieties yielded about 44 pounds of grain per additional pound of fertilizer. This high coefficient is the response to a whole complex of practices rather than to fertilizer alone. However, a response of 15 to 20 pounds of wheat per pound of fertilizer would seem reasonable for high-yielding varieties under average farm conditions.

Bajra, Maize, and Jowar.--Data are available on varietal tests for bajra for 1965-66. In all test areas, yields for hybrids were higher than for local varieties. Even without fertilizer application, the average yields in one set of tests were 1,856 kilograms per hectare for local varieties compared with 2,154 for hybrids (table 4). The large advantage of the hybrids over local varieties, however, lies in their capacity to use larger amounts of fertilizers and to use them more productively. For example, the first increment of 40 kilograms of N resulted in yield increments of 713 kilograms for local varieties but 1,407 for hybrids, twice as much as for local varieties. Again, these results suggest response ratios of better than 15 to 1 for fertilizers used.

Tests conducted for 4 years on double-cross-hybrids of maize indicate grain yields of 3,300 to 7,000 kilograms per hectare (up to 100 bushels per acre). In all tests, yields of hybrids were much above those of local varieties, running generally 40 to 50 percent higher.

Available data on jowar indicates that yields for hybrids average about 500 kilograms per hectare higher than those for local varieties. Response ratios for varying ranges of nitrogen application were substantially higher for hybrid varieties as shown in table 5.

In evaluating the above test results, it should be emphasized that they have been obtained on better-than-average farms with better-than-average provision of technical assistance. They do, however, indicate potentials which may be reached as India's farmers gain experience and knowledge of the new high-yielding varieties and of their input and tillage requirements.

Shifts in Policy

Food crises in the last 2 years have had a dramatic impact upon the thinking of policymakers at all levels--Center, State and local--in matters pertaining to agriculture. Hence the commercial adoption of new high-yielding varieties and provision of assured water supplies, fertilizers, plant protection materials, and other inputs that are part of the new technology have been greatly facilitated by a new sense of urgency and determination to avert food crises like those of 1965-66 and 1966-67.

New directions of effort are being pointed directly to increasing production through more adequate provision of essential inputs in contrast to emphasis in the 1950's upon major institutional reforms. The wisdom of the current policy is reflected in the increased use of fertilizers, improved seeds, and other inputs and the fact that institutional impediments are not currently bottlenecks to the utilization of these inputs.

Current operative policies and programs are treated in fuller detail following the sections on 1967-68 output and requirements for a 5-percent growth rate, so as to better relate current and prospective achievements more directly to requirements.

[9] Data in this report are discussed in the terms that they are reported in statistics from India. Here wheat yields are discussed in terms of pounds per acre.

Table 4.--India: Yields of hybrid and local varieties of bajra at varying rates of nitrogen application, trial at Fatehabad (Agra) Uttar Pradesh, Kharif 1965

Nitrogen	Yields of grain		
	Local varieties	Hybrids	Differences
	----------------Kilograms per Hectare----------------		
0	1,856	2,154	298
40	2,569	3,561	992
80	3,069	4,348	1,279
120	3,806	5,645	1,839
160	3,393	5,967	2,574

Source: (15).

Table 5.--India: Response ratios of local and hybrid varieties of jowar for varying rates of nitrogen application

Variety	Response ratios for ranges of nitrogen application of--		
	0 to 40 Kg/ha.	0 to 80 Kg/ha.	0 to 120 Kg/ha.
	------Kilograms of Jowar per Kilogram of Nitrogen-------		
Local........	14.2	4.8	--
Hybrid.......	19.2	16.1	13.0

Source: (17).

ESTIMATION MODEL FOR 1967-68 FOOD GRAIN OUTPUT

Although table 1 showed a trend extrapolation of output that would lead to a 1967-68 projection of about 95 million tons of food grain, forcasting production for a single year such as the current crop year depends upon the supply of inputs.

Methodology

An aggregative framework has been constructed for measuring the production response from these factors. Weather for this forecast is assumed to be normal.[10] In addition, it is assumed that relative prices are at levels which will provide cultivators the incentive to purchase the necessary inputs.[11]

The projection method used here measures the marginal product or output resulting from input changes from a base period to the period under review. The production responses from these input changes are based on likely input-output ratios, using fertilizer as the standard input.[12] This output added to the base period production results in the forecasted or projected output. This method has the

[10] Rainfall during the 1967-68 kharif and rabi seasons has been highly favorable.

[11] This also subsumes that credit is available when necessary for input purchases.

[12] See the discussion on "Recent Improvement in Food Grain Production Potentials."

advantage of taking into account any shift in the production function. The trend extrapolation, on the other hand, implicitly assumes no shift in the production function.

The base period used in this framework is the 3-year average centered on 1960-61. This period was selected for the following reasons: (1) Fluctuations in production caused by weather were relatively moderate; (2) fertilizer consumption was relatively low and the use of improved crop varieties was virtually nonexistent; (3) a projection base at the outset of the 1960 decade was convenient; and (4) it fitted the time references of previous projection studies (1) (12).

Inputs

The 1967-68 inputs for food grains used in this model are estimates based on targets of the Government of India; the self-help measures, as specified in Item V of the P.L. 480 agreement signed on February 12, 1967; and current reports on input supplies. They include the following:

...117.5 million hectares sowed to grains

...32.0 million hectares of gross irrigated grains area

...1.6 million tons of fertilizer in terms of plant nutrients nutrients applied to grains[13]

...6.1 million hectares sown with high-yielding varieties

Table 6 provides a comparison with the base-period inputs. In effect the model's task is to calculate the production response from incremental increases of 1.3 million sown hectares of food grains, 9.7 million gross hectares of irrigated area, 1.4 million tons of fertilizer, and 6.1 million hectares sown with high-yielding varieties.

Results

The model first accounts for the production increment attributed to only the increase in area, holding yields constant. This amounted to 885,000 tons, or 1.1 percent of the base-period production. Yields are held constant by increasing irrigation and fertilizer consumption at the same growth rate as area.

The next step estimates the increment resulting from the sowing of 6.1 million hectares of high-yielding grain varieties, with the assumption that all of this area will be irrigated and fertilized at the rate of 60 kilograms per hectare. Thus 366,000 tons of fertilizers are applied to 6.1 million irrigated hectares of high-yielding grain varieties. A response coefficient of 13.5 was assumed, resulting in a production increment of 4.9 million tons.[14]

The third step measures the output increment from the unused irrigated area of 3.3 million hectares: Only local varieties would be sown; a fertilizer application rate of 40 kilograms per hectare is assumed, which would amount to 133,000 tons. A response coefficient of 9.0 is assumed which results in additional output of 1.2 million tons.

The residual input is 944,000 tons of fertilizer. This fertilizer is applied to nonirrigated land with local varieties of grains. A response coefficient of 6.5 is assumed which results in a production increment of 6.1 million tons.

The final step totals the production increments and the base-period production, resulting in an estimate of 93.6 million tons of grains in 1967-68. Thus, this analysis more than supports the trend projections of 94 to 95 million tons. The difference between the estimated 93.6 million and the 92 million set for the base should be regarded as a margin of safety for uncertainities of weather, input supplies and distribution, and response coefficients.

The assumption in the third step of applying residual fertilizer to nonirrigated land only is a conservative element of this model. It could be reasonably assumed that at least a portion of the fertilizer might be applied to the irrigated area utilized in step one (22.6 million hectares), after accounting for the area increase. As the model stands, only 136,000 tons of fertilizer or an average of 5.9 kilograms per hectare is applied to this area. If all of the remaining fertilizer (944,000 tons) were applied, then the rate would jump to 47.7 kilograms per hectare. If other things

[13] Including N, P_2O_5, and K_2O. Hereafter a unit of fertilizer will be assumed to contain 4 parts N, 2 parts P_2O_5, and 1 part K_2O. It is assumed that food grains account for 75 percent of total fertilizer consumption.

[14] Response as used in this context refers to the output resulting from a combination of inputs, but the coefficient will always refer to the fertilizer in the combination.

This is believed to be a fairly conservative response ratio. It is used because of an awareness of technical problems commonly encountered in the rapid spread of new crop varieties and other new practices. As India's farmers gain experience in use of new varieties, the response ratio can be expected to approach the levels now being obtained in experiments and in the Intensive Agricultural District Program (IADP) where reasonably good programs of technical assistance have been developed. (The IADP was initiated as a joint effort of the Ford Foundation and the Center. For a more detailed description see (11).)

Table 6.--India: Model for estimating 1967-68 food grain production

Inputs and outputs	Units	1959-60 to 1961-62 average[1]	Estimates for 1967-68[2]	Estimates of grain output increases from 1959-60 to 1961-62 (Ave.) to 1967-68 with following input increases[3]				
				Area	High yield varieties	Irrigation with local varieties	Fertilizer with non-irrigated local varieties	Total increases
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Inputs:								
Grain Area..............	1,000 hectares	116,212	117,500	1,288	0	0	0	1,288
Gross irrigated Grain area.............	1,000 hectares	22,318	32,000	245	6,100	3,337	0	9,682
Fertilizer for Grain..................	1,000 tons	131	1,575	1	366	133	944	1,444
High-yielding Varieties..............	1,000 hectares	0	6,100	0	6,100	0	0	6,100
Output:								
Increments............	1,000 tons	---	13,159	885	4,941	1,197	6,136	13,159
Total...............	1,000 tons	80,465	93,624	---	---	---	---	---

[1] Irrigated grain area accounts for about 80 percent of total irrigated area. It is assumed that 40 percent of total fertilizer was applied to grain.

[2] Irrigated grain area accounts for 80 percent of total irrigated area. It is assumed that 75 percent of total fertilizer was applied to grains. Output expected with average wether conditions and with indicated inputs.

[3] Increases in grain output estimated as follows:

Column 3 - Yield held constant; production, irrigated area, and fertilizer increases at rate of area increase (1.1 percent).

Column 4 - High yield varieties grown on irrigated land and fertilized at 60 kg/ha; assumed yield response of 13.5 kg. grain for 1 kg. of fertilizer.

Column 5 - Fertilizer applied at 40 kg/ha; assumed yield response of 9 kg. grain for 1 kg. fertilizer.

Column 6 - Residual amount of fertilizer available assumed to have a yield response of 6.5 kg. grain for 1 kg. fertilizer.

are held constant, the output response from fertilizer is higher on irrigated land than on nonirrigated land (16). An increase in the response coefficient from 6.5 to 9.0 would then result in an additional 2.4 million tons of food grains.

If the input and production estimates for 1967-68 prove to be correct and output is merely near the trend level, it would suggest that the input base--fertilizers, high-yielding varieties, and irrigation--must be accelerated substantially over recent rates in order to reach a desired annual growth rate of 5 percent in the near future. The input base of 1967-68 is vastly improved from recent years, but apparently it will only substitute for the rapid expansion in area and increases in other production factors during the fifties in sustaining the historical growth rate.

REQUIREMENTS FOR A 5-PERCENT GROWTH RATE, 1967-68 TO 1970-71

At an annual growth rate of 5 percent from a 1967-68 estimated output of 92 million tons, India's grain production would reach 106 million tons in 1970-71. With this objective in view, the immediate task is to find what input base would be required to reach this output objective.

Inputs

For this computation the following assumptions were made:

...Normal weather will prevail;

...relative producer prices will be at levels which will provide cultivators the incentive to purchase and use the projected inputs;[15]

...the gross grain area will total 121 million hectares, 3 percent above the estimated 1967-68 level.[16] It is expected that part of this increase will be the result of multiple-cropping;

...the gross irrigated grain area will total 38.0 million hectares;[17]

...the area sown with high-yielding varieties will total 13.2 million hectares (the fourth plan target);

...the area of high-yielding varieties will be irrigated and fertilized at the rate of 80 kilograms per hectare. The response coefficient is 13.5;

...fertilizers will be applied to the irrigated area with local varieties at the rate of 60 kilograms per hectare. The response coefficient is 9.0;

...an input-output coefficient of 6.5 for fertilizer applied to nonirrigated area with local varieties.[18]

The 1970-71 level of three input variables--land, high-yielding varieties and irrigation--has already been assumed or projected, simplifying the task of computing an input base. To compute the quantity of fertilizer necessary to reach 106 million tons, the model used to measure the marginal response of input increases is essentially the same as that used for the 1967-68 estimate. Again the base period is centered on 1960-61. The model must now find the necessary fertilizer, given other inputs and output, whereas for 1967-68 its assignment was to find output given the inputs.

Results

The computational steps follow the pattern of the 1967-68 input model as shown in table 7. The first calculation is the production increment resulting from the area increase (holding yield constant) of 4.8 million hectares; this amounts to 3.3 million tons. To hold yield constant requires 4,000 tons of fertilizer and 915,000 hectares of irrigated area in excess of the base-period levels.

The additional output resulting from the use of 13.2 million hectares of high-yielding varieties is computed in the second step; this totals 14.3 million tons. To reach this level requires 13.2 million hectares of irrigated area and 1.1 million tons of fertilizer in excess of the base-period levels.

The third step calculates the production increment from the residual irrigated area (1.6 million hectares) using local varieties, which amounts to 846,000 tons and requires 94,000 tons of fertilizer.

The fourth step computes the fertilizer necessary to bring total production to 108.0 million tons. The necessary output increment is 9.1 million tons and assuming a

[15] This also subsumes that credit is available when necessary for input purchases.

[16] The area increase is taken as a trend extrapolation as projected in (20).

[17] Irrigated food grain area accounts for about 80 percent of total gross irrigated area.

[18] As was noted in the discussion of the input basis for 1967-68, this assumption provides a conservative element to the model.

Table 7.--India: Model and input base for projecting 1970-71 food grain production at 108 million tons[1]

Inputs and output	Unit	1959-60 to 1961-62 average[2]	Estimates for 1970-71[3]	Estimates of grain output increases from 1959-60 to 1961-62 (Ave.) to 1970-71 with following input increases[4]				
				Area	High yield varieties	Irrigation with local varieties	Fertilizer with non-irrigated local varieties	Total increases
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Inputs:								
Grain area............	1,000 hectares	116,212	121,000	4,788	0	0	0	4,788
Gross irrigated grain area...........	1,000 hectares	22,318	38,000	915	13,200	1,567	0	15,682
Fertilizer for grain................	1,000 tons	131	2,691	5	1,056	94	1,405	2,560
High-yielding varieties............	1,000 hectares	0	13,200	0	13,200	0	0	13,200
Output:								
Increments............	1,000 tons	--	27,535	3,299	14,256	846	9,134	27,535
Total...............	1,000 tons	80,465	108,000	--	--	--	--	--

[1] The 108 million tons is the level output must reach to attain an annual growth rate of 5 percent from the 1967-68 estimate in table 6.

[2] Irrigated grain area accounts for about 80 percent of total irrigated area. It is assumed that 40 percent of total fertilizer was applied to grain.

[3] Irrigated grain area accounts for about 80 percent of total irrigated area. It is assumed that 75 percent of total fertilizer was applied to grain.

[4] Increases in grain output estimated as follows.

Column 3 - Yield held constant; production, irrigated area, and fertilizer increases at rate of area increase (3.0 percent). Area taken as trend extrapolation as projected by Holst (20).

Column 4 - High-yield varieties grown on irrigated land and fertilized at 80 kg./ha.; assumed yield response at 13.5 kg. grain for 1 kg. of fertilizer.

Column 5 - Fertilizer applied at 60 kg./ha.; assumed yield response of 9 kg. grain for 1 kg. fertilizer.

Column 6 - Assumed yield response of 6.5 kg. grain for 1 kg. fertilizer and then computed the amount of fertilizer necessary to produce 9.1 million tons of grain--the quantity needed to reach a total output of 108.0 million tons of grain.

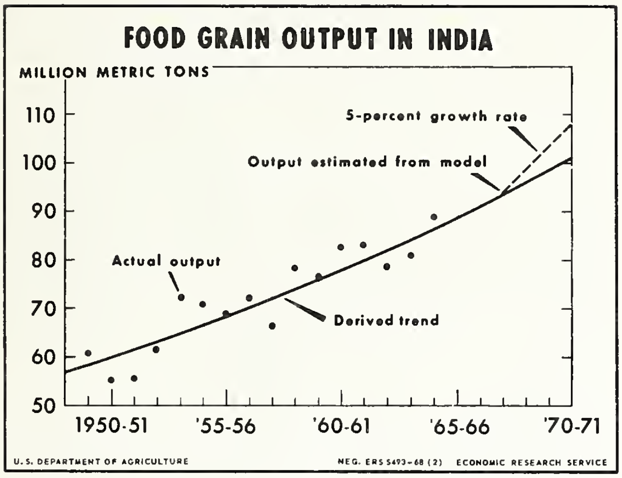

Figure 1

response coefficient of 6.5, the fertilizer requirement is 1.4 million tons.

Therefore, 2.7 million tons of fertilizer together with the gross food grain area of 121 million hectares, the high-yielding variety area of 13.2 million hectares, and an irrigated area of 38.0 million hectares would result in a total output of 108 million tons. The 2.7 million tons of fertilizer represents only that portion of the total supply that is applied to grains.[19] The total fertilizer supply in this case would equal about 3.6 million tons.

Thus, with average weather, 1970-71 grain production should reach 106 million tons and is projected at 108 million tons. The difference between the 108 million and the 106 million set as the objective should be regarded as a safety margin for uncertainties of weather, input supplies and distribution, and assumed response coefficients (fig. 1).

The results of this combination of inputs are somewhat surprising in view of India's fourth plan targets. The gross irrigated area and fertilizer consumption are below the target by about 5 percent and 13 percent, respectively. However, the targets are aimed at the production of 120 million tons of grains, and not the 108 million tons projected here.

But these differences pose the question, "what would be the level of grain output if the targets were fulfilled?" Using the same framework as above with the following inputs:

...total grain area	121.0	million hectares
...gross irrigated grain area	40.0	million hectares
...high-yielding varieties area	13.2	million hectares
...fertilizers used for grains	3.1	million tons

the production of grains would total 111 million tons.

On balance therefore, it appears that the objective of an annual growth of 5 percent is attainable with likely supplies of inputs, and could, in fact, be exceeded. But to do so will require a continuous push to effectively acquire and distribute the necessa- inputs for cultivator use. Embedded d within the framework of the model i. assumption that the growth of India's "ag industry" will be adequate to serve rising demands of agriculture. This avoi a host of problems which inevitably wil arise during the course of the next 3 years. The scope of this report precludes a comprehensive discussion of these problems but they are important enough to warrant the comments in the following sections.

POLICIES AND PROGRAMS

The preceding section indicates that a 5-percent growth rate in food grain production is technically and economically feasible for the period 1967-68 to 1970-71. Moreover, important foundations for moving out along, or above, this growth line have already been laid and the Center is moving forward to insure such growth.

Previous pessimism about India's grain prospects has been based on two conditions--

...targets for inputs were inadequate to set off and sustain such growth;

...performance has fallen short in fulfilling these low input targets.

In contrast to this past record, recent conditions have changed:

...input targets have been substantially raised; and

...performance against even these higher targets promises to more closely match requirements for their fulfillment.

The Center is pressing vigorously to meet input needs through rapidly expanding domestic production and committing scarce

[19] It has been assumed that 75 percent of the total supply of commercial fertilizers is applied to food grains.

foreign exchange for imports of needed inputs that cannot be supplied domestically. Despite a generally tight budget situation, the Center has greatly increased allocations for agriculture.

High-Yielding Varieties

A dramatic example of the vigor of the Center's efforts to improve agriculture is the importation of Mexican dwarf wheat in 1966. Based upon the results of variety tests in the spring of 1966, the Minister of Food and Agriculture and the State Chief Ministers proposed the importation of $5 million worth of Mexican seed wheat for the 1966-67 rabi (spring) planting. This was cleared through the Finance Ministry within 24 hours. Within a week, Indian seed specialists were in Mexico making field purchases of wheat. The result was that the world's largest seed shipment on record, 18,000 tons, arrived in India within 3 months, in time for planting an estimated 600,000 acres (243,000 hectares).

As mentioned earlier, supplies of high-yielding varieties of rice, wheat, maize, jowar, and bajra are now adequate to plant 15 million acres (6.1 million hectares) in 1967-68 (tables 6 and 15).

Supplying seed for expanding the area of high-yielding varieties to 32 million acres (13.2 million hectares) by 1970-71 should pose no serious difficulty. Basic plant germ plasms from which to develop new varieties with larger yield potentials and improved quality are now available for all major cereal crops. Supplies of such materials for pulse crops are also being collected by USDA geneticists working in cooperation with Indian research agencies under an AID-USDA Participating Agency Services Agreement.

The limited number of trained personnel constitutes a major bottleneck on the speed with which supplies of hybrid jowar, bajra, and maize seed can be increased and therefore affects adversely the rate at which the area of high-yielding varieties can be increased.

In the past, it has often been difficult to maintain high standards of purity and quality of seed supplies--even in some cases for State seed farms. Programs to insure purity and quality of commercial seed stock need to be strengthened throughout most of India. A step in this direction was the recent passage of a National Seed Law to provide quality controls through seed certification and registration procedures. Implementing legislation by the States, which is now under discussion, will be necessary to make the National Seed Law effective.

In the multiplication of improved varieties, heavy emphasis has heretofore been placed on State seed farms. Currently, however, the private sector is being used extensively to supplement State seed farms, which will help to insure adequacy of seed supplies needed to sustain a rapid rate of growth. It is not clear, however, that much encouragement is being given to use of private firms to produce seed.

Fertilizers

There has been a spectacular change in the fertilizer situation during the past 2 years. Previously there was concern that supplies would exceed demand and attention had been focused on avoiding a possible glut. But with the recent technological developments and relatively high foodgrain prices, present efforts are directed to meeting a rapidly increasing demand for fertilizers. This shift is demonstrated in various ways:

...Fertilizer availability targets for the fourth plan are up 4 to 5 times over third plan availabilities; domestic production targets show the greater increase but foreign exchange has been committed to imports necessary to meet the balance of targets.

...India's performance in the first two crop years of the fourth plan (1966-67 and 1967-68) has been creditable. Nitrogen available for the first agricultural year of the plan was over 900,000 metric tons--an increase of 55 percent over the previous year and about 90 percent of the goal. Similarly, availability of nitrogen for the second agricultural year will increase 45 percent to over 1.3 million metric tons. Availability of P_2O_5 doubled the first year and increased an additional 50 percent in the second; K_2O availability showed smaller but still significant gains.

...There have been N and P_2O_5 shortfalls in the production sector, stemming from shortages of raw materials and drought-aggravated power shortages. Nonetheless, production has risen substantially, both absolutely and as a percentage of target fulfillment. Even more encouraging has been the Center's evident willingness to commit very scarce foreign exchange and to carry through on importations of N and P in excess of import targets as well as improving the imports of K.

...Earlier commitment of funds against pending budgets has permitted more timely placing of fertilizer orders in the last 2 years.

...Difficulties experienced by the State Trading Corporation in obtaining sulfur in January 1967 led to formation of a joint Government-Industry Fertilizer Allocation Committee to review import requirements and prospective contracts. Current estimates indicate that the 600,000-ton annual requirement will be met and possibly exceeded. Proliferation of buyers, including private traders, and the freedom to develop a variety of contract patterns have widened the supply prospects and resulted in price benefits on longer term contracts.

...Contract negotiations to build manufacturing plants have been expedited.

Irrigation

Compared with the third plan, the fourth has given emphasis to minor irrigation expansion;[20] allocations for minor irrigation increased by 93 percent while those for major and medium increased only 47 percent--a good part of which represents completion of previous projects.

These target increases should also be viewed in the context of third plan performance, which exceed targets for minor irrigation projects but fell short of major to medium targets. For the first year of the current plan period, 28 percent of the minor irrigation target area was covered.

There has also been a significant shift in the pattern of minor irrigation programs. In the first plan, the additional areas irrigated by surface (tanks[21] and canals) and ground (wells) water development were about equal, whereas in the fourth plan, the area increment expected from ground water development is more than double that from surface water.

Of the various types of irrigation wells to be developed, expansion of well construction programs are clearly emphasizing private over public ownership. Compared with the previous plan, the number of additional private tubewells is planned to increase nearly 160 percent while public tubewells will increase 100 percent; the former will serve an area nearly twice as great as the latter.

The planned increase in motorized pumps for wells (243 percent of third plan achievement for electric and 112 percent for diesel) will further reinforce the production potential from the increased well construction in the fourth plan. For example, the State of Uttar Pradesh originally planned to install 10,000 pumps in 1966-67; later, with drought conditions prevalent, the target was raised to 17,000 and was reached before the end of the fiscal year. Rural electrification has a high priority in the current plan. The Center estimates, as a result, that they will be able to remove the present 2-year delay in well installation within the next few years. This development would obviate the alleged preference given to public wells in obtaining power connections in some areas. It is estimated that the rate of well construction increased 50 percent between 1965-66 and 1966-67; further increases are expected in 1967-68.

A variety of measures are being taken to increase the effectiveness of irrigation programs. The Ayacut (command area) Development Program was recently organized at the Center to promote integrated local development of irrigation projects in such related spheres as shaping of channels, changing cultivation practices, assuring needed inputs, and water management measures. More generally, a Water Utilization Unit has been organized within the Ministry of Food and Agriculture to direct the Ayacut Program and to promote better utilization of water resources through coordination of irrigation agencies. Through the Ayacut Program and the Water Utilization Unit, there should be gains in integrated local focus as well as better top-level coordination of irrigation activities.

There has been an appreciable increase in credit resources through established institutions (Land Development Banks, and Agricultural Refinance Corporation) for financing wells and grading land. The formation of new credit institutions for similar purposes is now under consideration.

Plant Protection Materials

The advent of the high-yielding varieties highlights the need for more disease and pest control measures. The new varieties

[20] Irrigation projects in India are classified according to cost: major ($6.7 million plus); medium ($0.13 to $6.7 million); and minor (less than $133,300).

[21] Ponds, lakes, or reservoirs are commonly referred to in India as "tanks," and driven wells as "tubewells."

are amenable to much denser planting; the larger plant populations lead directly to greater insect populations, and provide an environment for the spread of disease. With traditional varieties, the profitability of plant protection measures was marginal at best, but a comprehensive control program is profitable for the high-yielding varieties.

Plant protection benefited from the Center import liberalization in 1966 which freed the importation of needed technical ingredients; production of plant protection materials for 1967-68 is estimated to be nearly 20 percent greater than for the preceding year. The Center has recently agreed to continue subsidizing the cost of producing pest control materials.

The area covered by pest control measures has increased sharply from 16.6 million hectares in 1965-66 to 25.5 million hectares in 1966-67; 51 million hectares are planned for 1967-68. This increase, however, does not indicate the effectiveness of such action. The area may or may not be thoroughly covered; the actual need for protection--from a locust infestation, for instance--may vary greatly from year to year; climatic variations also influence the need for protection; and there are many alternative means for protection as well as alternative protection needs. However, a "survey and warning" system is being established to arrest any potentially serious infestation before epidemic proportions are reached.

Transport Facilities

To achieve the annual growth rate of 5 percent in food grain production will require even higher rates of growth for all major inputs except land. The projected annual rates of growth are 1.0 percent for grain area; 5.9 percent for irrigated grain area; 29.5 percent for the area under high-yield varieties; and 19.5 percent for fertilizer consumption (table 14).

These high rates must be accompanied by a substantial expansion in the facilities that supply and distribute farm inputs to the cultivator. In fact, the 5-percent annual growth rate in grain production in itself will require additional marketing facilities that can effectively transfer the food grains from the producer to the consumer.

Transportation is the underpinning of an agricultural marketing and distribution system. In almost every developing country, the network of access roads between farms and local market towns is still inadequate. In India, there is only about 0.7 mile of road per square mile of cultivated land, compared with about 4 miles in the United Kingdom, France, Japan, and the United States.

It has been estimated that in India a million miles of roads will have to be constructed to satisfy the access needs of 580,000 villages throughout the country. Only 11 percent of these villages now have reasonably adequate roads and one out of three is more than 5 miles from a satisfactory road (20).

The most important transport program for Indian economic development in the fourth plan would be to concentrate on the agricultural sector to permit the distribution of necessary farm supplies and to make possible the marketing of farm commodities. With sharply rising supplies of farm inputs and the increased output that is anticipated from these inputs there is an immediate urgency in developing an adequate transport network.[22]

Agricultural Credit

In the past year there has been direction in forming new credit institutions (or reorganizing existing institutions) and in increasing funds for credit purposes, including:

...For 1967-68 expansion of credit funds for agricultural purposes, the Center has published commitments to expand credit by over Rs. 95 crores[23] ($126.7 million) with at least an additional Rs. 5 crores ($6.7 million) promised if performance by credit institutions in lending is adequate: Nearly Rs. 17 crores ($22.7 million) are allocated to medium/long term facilities (1.4 to Land Development Banks and 15.5 to the Agricultural Refinance Corporation), an additional Rs. 9 crores ($12.0 million) to medium-term lending (the newly formed Agro-Industries Corporations) and Rs. 70 crores ($93.3 million) to short-term lending (25 through the cooperatives and 45 in support of input program lending). The additional 5 crores ($6.7 million) promised will go to the Land Development Banks upon demonstration of effectiveness of the new levels.

[22] For a discussion of a suggested transportation program for India see (20) vol. II, pp. 589-592.

[23] The rupee (Rs.) is the basic monetary unit in India. Since June 6, 1966, it has been officially valued at $0.1333 (U.S.). A crore is 10 million.

...The recent creation of the Agro-Industry Corporations and pending Government legislation setting up Agricultural Development Corporations in States having weak cooperative lending institutions.

...The Center has been considering suggestions for still other agricultural credit institutions or patterns of rural lending, especially those related to fertilizer distribution and construction of wells.

...Recently, the Association of Indian Commercial Banks has announced the intention of setting aside a fund of Rs. 350 crores ($466.7 million) for agricultural production lending. This step was taken as a partial answer to the growing public criticism of the unwillingness of commercial banks to share the responsibility for rural credit needs. While the details have not yet been worked out on the operation of this fund, there are indications that it will be directed first toward greater credit facilities for individual cultivators and then for utilization by input suppliers and the distribution channels.

Agricultural Research and Education

In the field of research, the Rockefeller Foundation, through its coordinated research programs for hybrids and new wheat and rice varieties, has contributed substantially to the present promise of the high-yielding varieties program. These efforts are being augmented by the research programs conducted by the Indian Agricultural Research Institute at the Center and various research facilities in the States. A recently signed agreement between the Center and the International Rice Research Institute is a further indication of future research emphasis for this important food crop.

Agricultural research of late has been coming closer to field operations: In 1967-68 scientists of the Indian Council of Agricultural Research (ICAR) will continue to organize national demonstration projects in the field which will be supplemented in several States by demonstration farms with the assistance of an agricultural extension staff. A coordinated research program for about 20 commodities in various States has been undertaken by the ICAR in collaboration with the State Governments.

The AID Mission programming of Field Problems Research Teams is a healthy development relating research, extension, and operations. Currently operating in four States, these five-man teams are actively engaged in promoting better use of fertilizer, seeds, plant protection inputs, and water management by expediting and promoting the linkage between field experiences, research facilities, and extension activities within the States. Working with State agencies on the one hand and agricultural universities on the other, these field units will also underscore the work of the Mission's agricultural universities program which is oriented to a more pragmatic and unified relation between teaching, research, and extension.

The degree of success experienced by the Center in developing the foregoing and related programs will determine the long-run ability of the agricultural sector to maintain the projected growth trend.

Incentives

The situation with respect to price policies is currently more uncertain and confused than that relating to any other major requirement for sustaining a rapid rate of growth in food grain production. Creation of the Agricultural Prices Commission in 1965 indicates an awareness of the need for more rational price policies. Whether actual improvements have been made in India's agricultural price policies remains to be seen.

Prices of food grains at the time this report was written were favorable throughout India, a fact best attested to by the current demand for fertilizer and other inputs. Price relationships among States and between commodities are, however, greatly distorted and are wholly inconsistent with objectives of efficiency in allocation of scarce inputs and with that of efficiency in food distribution (tables 12 and 13). The reason for this is the existence of the State zonal system prohibiting free interstate trade in grains.

India's zonal system is currently depressing prices of grains in localities having the largest comparative advantage in their production and inflating grain prices in deficit producing areas. Under present demand-supply relationships applicable to fertilizers and other major inputs, these distorted price relationship have little effect upon the overall amount of these inputs now being used. However, unless counteracted by appropriate administrative allocative controls, such distortion of price relationships must be an added source of inefficiency in the allocation of scare inputs that are strategic to India's food needs. There will inevitably be inefficiency in allocation of the nation's supplies of seeds, fertilizers, and other inputs simply because of the speed with which these supplies have been increased. This "administrative" inefficiency is an added waste at a time when efficiency is of the utmost importance, not only for achieving the nation's food production targets, but for the conservation of foreign exchange.

Currently, India has a system of support prices, but the announced level of these supports falls so far below both current price levels and those for 1962-63 to 1964-65 that they can hardly be called incentives.

As India's food grain production approaches a 5-percent per year growth rate, it will likely cause a downturn in food grain prices from their presently high scarcity levels. This in itself would pose a very delicate and difficult analytical problem which could be the next hurdle for Indian administrators to cope with: How to determine the level of price supports needed to insure adequate producer incentives without, however, distorting price relationships and constraining the role of free market prices.

REFERENCES

(1) Abel, Martin E. and Rojko, Anthony S.
1967. World Food Situation. U.S. Dept. Agr., Foreign Agr. Econ. Rpt. 35, Aug.

(2) Central Statistical Organization, Cabinet Secretariat, Government of India
Estimates of National Income, 1950-51 and 1955-56 to 1959-60.

(3) Directorate of Economics and Statistics, Ministry of Food, Agriculture, Community Development and Cooperation, Government of India

(4) ________
1961-67 Agricultural Prices in India, Various Issues.

(5) ________
1961-67 Agricultural Situation in India, Various Issues.

(6) ________
1961-67 Bulletin on Food Statistics, Various Issues.

(7) ________
1966. Growth Rates in Agriculture, 1949-50 to 1964-65, March.

(8) ________
Land Utilization Statistics--All India, 1950-51 to 1962-63.

(9) ________
1967. Area, Production and Yield of Principal Crops in India, 1949-50 to 1966-67; Summary tables. Oct.

(10) Fertilizer Association of India
1967. Fertilizer Statistics.

(11) Ford Foundation
1967. A Richer Harvest, Oct.

(12) Foreign Regional Analysis Division, Economic Research Service
1964. The Word Food Budget, 1970. U.S. Dept. Agr., Foreign Agr. Econ. Rpt. 19, Oct.

(13) Hall, William F.
1964. Agriculture in India. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign 64, Jan.

(14) Indian Council of Agricultural Research and Cooperating Agencies
1966. Progress Report of the All India Coordinated Rice Improvement Project, Kharif, 1966.

(15) ________
1967. Progress Report of the Coordinated Millets Improvement Program, 1965-66.

(16) Institute of Agricultural Research Statistics
1964. Yardsticks of Additional Production of Certain Food Grains, Commercial, and Oilseed Crops. New Delhi.

(17) International Bank for Reconstruction and Development
1967. Indian Economic Policy and the Fourth Five-Year Plan. Vol. II. Agricultural Policy in India. March.

(18) Leftwich, Richard H.
1961. The Price System and Resource Allocation. Holt Rinehart and Winston, New York.

(19) Lewis, John P.
1964. Quiet Crisis in India, Doubleday, Garden City, New York.

(20) President's Science Advisory Committee
1967. The World Food Problem. Volumes I and II. May.

(21) Sen, S. R.
1967. Growth and Stability in Indian Agriculture. Agricultural Situation in India. Jan.

APPENDIX

Comments on a Report of the President's Science Advisory Committee, The World Food Problem (20)

General Report.--There are no basic inconsistencies between the report of the President's Science Advisory Committee (PSAC), The World Food Problem, and the analysis presented in this report. The former is properly global in its view. It is addressed to a very wide range of problems treated in broad general terms without assignment of priorities and without reference to specified constraints in respect to budgetary considerations, input availabilities, and many other items that are specific to our own situation. In developing this report, we have attempted to assess development potentials and requirements under conditions that are specific to India. We have attempted to project a program that we believe is attainable, yet challenging, within limits of budgetary, resource, organizational, and other constraints applicable to India.

In our analysis we have also placed heavy emphasis upon programs with good promise of large increases in food production in the near term. India's current food crisis, very recent but large improvements in food grain technology, and recent shifts of emphasis in the Indian Government's food production policies all make this emphasis upon achieving large early increases in output desirable. Measures to achieve these shortrun gains will, however, help to strengthen long-term development programs, including those of agricultural education, extension, and research.

This report, as well as recent policy emphasis of both the AID Mission to India and the Government of India is fully consistent with the high priority assigned in the PSAC report "to providing production inputs essential to accelerating agricultural productivity."

The Mission's program in support of agricultural education, extension, and research is being strengthened by the addition of U.S. agricultural experts to work jointly with Indian Universities and State Departments of Agriculture in production promotion activities.

The Holst Paper.--Compared with the "self-sufficiency" figure of 113.5 million tons of food-grains needed for 1971 in the Holst model (a chapter in (20, vol II), our figure (106 million tons) of that which is attainable is conservative. However, there are several differences between the information and assumptions used here and those used by Holst:

...His model includes in the concept of self-sufficiency an increase in the nutritional level of the population which would increase the total needed by some unspecified amount.

...Drawing on seed and fertilizer responses derived from 1963-64 data, he projects from a technological base which has been dramatically altered by the unexpected and rapidly spreading introduction of new varieties of wheat, paddy, and hybrids. These high-yielding varieties, when coupled with the equally rapid and dramatic rise in fertilizer availability, will produce in the immediate future, and on a sustained basis thereafter, levels of production not anticipated until years later in his model.

...Another point of difference is the historical growth rate of agriculture and, therefore, the normative base from which he projects. We have demonstrated that a good part of the flattening of the growth curve which Holst notes in the late 1950's and early 1960's can be attributed to markedly poor weather. Grain prices were relatively low which would have also contributed to the flattening of the curve, but prices have shifted greatly in favor of grains since 1963-64. Therefore, given the higher base level for projections which we feel is justified and in view of the input/output changes consequent on the new technology now well in process in India, our estimates can be viewed as more conservative than Holst's.

...Finally, Holst uses a loss figure which is much larger than that customarily used by either the AID Mission or the Center. While it may reasonably be argued that some higher loss figure is justified, currently there is no firm basis for making it as high as in the Holst model nor does his projection appear to consider the determined efforts now being made by the Center to improve storage facilities; to rapidly expand the plant protection program; to develop improved grain varieties;

and to initiate rodent control programs. All of these efforts are having, and will continue to have, an influence in reducing losses. (Loss estimates are not relevant to the output projections made in this analysis, but they do bear on the extent to which these output levels fulfill the objective of self-sufficiency in food grain consumption.)

Model for Estimating Food Grain Output

A simple model is constructed in this study to measure the marginal product of food grains resulting from increases in basic agricultural inputs. The model is discussed subjectively in the text. A more formal presentation is given below:

$O' = O_b + M.P.$, when

O' = food grain output estimate

O_b = food grain output in base period (1959-60 to 1961-62)

M.P. = Marginal product of food grain resulting from increases in basic agricultural inputs where

$M.P. = O_a + O_{hyv} + O_i + O_f$ when

O_a = food grain output resulting mainly from area expansion.

O_{hyv} = food grain output resulting from increased use of high yielding varieties, given irrigation and fertilization at the rate of 60 kilograms per hectare.

O_i = food grain output resulting from residual increase in irrigated food grain area, assuming area planted with local varieties and fertilized at the rate of 40 kilograms per hectare

O_f = food grain output resulting from residual increase in fertilization, assuming it is applied to local varieties and

$O_a = (\Delta A)(O_b)$ when

ΔA = percentage change in food grain area

$O_{hyv} = (13.5)(60.0)(\Delta HYV)$ when

13.5 = assumed response ratio where one unit of fertilizer yields 13.5 units of grain

60.0 = rate of fertilization in kilograms per hectare

ΔHYV = change in area of high yielding food grain varieties in thousand of hectares

$O_i = (9.0)(40.0)[\Delta I - (\Delta A \cdot I_b + \Delta HYV)]$ when

9.0 = assumed response ratio where one unit of fertilizer yields 9.0 units of grain

40.0 = rate of fertilization in kilograms per hectare

ΔI = change in irrigated food grain area in thousand hectares

I_b = irrigated food grain area in the base period in thousands of hectares

$O_f = (6.5)\left[\Delta F - (A \cdot F_b + O_{hyv}/13.5 + O_i/9.0)\right]$

6.5 = assumed response ratio where one unit of fertilizer yields 6.5 units of grain

ΔF = change in fertilizer consumption in thousand tons

F_b = fertilizer consumption in base period in thousand tons

Given the following for 1967-68:

O_b = 80,465,000 tons

ΔA = 1.1 percent

ΔHYV = 6,100,000 hectares

ΔI = 9,682,000 hectares

I_b = 22,318,000 hectares

ΔF = 1,444,000 tons

F_b = 131,000 tons

Solve for O'_{67-68}

$O_a = (.011)(80{,}465)$
$= \underline{\underline{885{,}000}}$ tons

$O_{hyv} = (13.5)(60.0)(6{,}100)$
$= \underline{\underline{4{,}941{,}000}}$ tons

$O_i = (9.0)(40.0)[9{,}682 - (245 + 6{,}100)]$
$= (360.0)(3{,}337)$
$= \underline{\underline{1{,}197{,}000}}$ tons

$O_f = (6.5)[1{,}444 - (1 + 366 + 133)]$
$= (6.5)(944)$
$= \underline{\underline{6{,}136{,}000}}$ metric tons and

$M.P. = 885 + 4{,}941 + 1{,}197 + 6{,}136$
$= 13{,}159{,}000$ tons and

$O'_{67-68} = 80{,}465 + 13{,}159$
$= \underline{\underline{93{,}624{,}000}}$ tons

TABLES

Table 8.--India: Food grain production by States, 1964-65 to 1966-67

State	1964-65[1]	1965-66[1]	1966-67[2]	(3/2)	(3/1)
	(1)	(2)	(3)	(4)	(5)
	Thousand metric tons			Percent	
Northeast:					
Assam	1,966	1,903	1,848	97	94
Bihar	7,532	7,148	4,225	59	56
West Bengal	6,260	5,448	5,394	99	86
Orissa	4,946	3,737	4,246	114	86
Nagaland	43	43	47	109	4
North and Northwest:					
Uttar Pradesh	15,289	13,311	12,459	94	81
Punjab	[3] 7,224	3,453	4,179	121	58
Rajasthan	5,308	3,839	4,338	113	82
Jammu & Kashmir	566	480	648	135	114
Haryana	([4])	1,977	2,606	132	([4])
Central and West Central:					
Madhya Pradesh	10,209	6,807	6,347	93	62
Gujarat	2,816	2,305	2,310	100	82
Maharashtra	6,838	4,722	6,216	132	91
South:					
Andhra Pradesh	7,634	6,219	7,660	123	100
Madras	5,739	5,251	5,830	111	102
Mysore	4,531	3,134	4,077	130	90
Kerala	1,150	1,025	1,123	110	98
Union Territories:	948	1,228	1,497	125	158
Total all India	88,996	72,030	75,049	104	84
Total minus Bihar	81,464	64,882	70,824	109	87
Total minus Bihar, U.P. & M.P	55,966	44,764	52,018	116	93

[1] Partially revised estimates.
[2] Final estimates.
[3] Includes Haryana.
[4] Included under Punjab.

Source: (3).

Table 9.--India: Food grain production by crops, 1964-65 to 1966-67

	1964-65[1]	1965-66[1]	1966-67[2]
Cereals:	--------Million metric tons--------		
Kharif[3]			
Rice:			
Autumn........................	16.15	11.90	13.34
Winter........................	21.53	17.61	15.36
Total rice..................	37.68	29.51	28.70
Jowar.........................	6.26	4.78	5.09
Bajra.........................	4.46	3.65	4.50
Maize.........................	4.66	4.76	4.99
Ragi..........................	1.90	1.18	1.60
Small millets.................	1.95	1.65	1.67
Total kharif cereals..............	56.91	45.53	46.55
Rabi[4]			
Rice: Summer..................	1.35	1.15	1.74
Wheat.........................	12.29	10.42	11.53
Barley........................	2.52	2.38	2.45
Jowar.........................	3.49	2.75	3.86
Total rabi cereals................	19.65	16.70	19.58
Total cereals.........................	76.56	62.23	66.13
Pulses			
Kharif............................	3.61	3.09	3.07
Rabi..............................	8.83	6.71	5.85
Total pulses..........................	12.44	9.80	8.92
Total food grains.....................	89.00	72.03	75.05

[1] Partially revised estimates.
[2] Final estimates.
[3] Kharif refers to the fall and winter harvest.
[4] Rabi refers to the spring harvest.

Source: (3)

Table 10.-- India: Yield of major food grain crops shown with and without irrigation, 1964-65

Crops	Irrigated		Nonirrigated		Yield difference (2)-(4) Kg/Ha.
	Hectares (000)	Yield (Kg/Ha.)	Hectares (000)	Yield Kg/Ha.	
	(1)	(2)	(3)	(4)	(5)
Rice	13,424	1,371	22,940	899	472
Wheat	4,858	1,173	9,602	766	407
Jowar	681	734	17,257	536	198
Bajra	268	560	11,458	378	182
Maize	551	1,452	4,067	949	503
Ragi	347	1,009	2,090	741	268
Barley	1,294	1,159	1,390	736	423
Gram	1,374	873	7,522	610	263
Other	966	621	18,444	434	187
Total food grains	23,763	1,229	93,779	836	393

[1] These yield differences reflect not only the influence of irrigation on yields but that also of associated differences in inputs of fertilizers, seeds, pesticides, and management. It is believed that most of the fertilizers used in India in 1964-65 was used on irrigated crops; also that improved seeds are more commonly used on irrigated than on nonirrigated land.

Table 11.--India: Statewide growth rates (compound) of agricultural production, area and productivity, 1952-53 to 1964-65

State	Production	Area	Productivity
	---Percent---		
Above average:			
Punjab	4.56	1.90	2.61
Gujarat	4.55	0.45	4.09
Madras	4.17	1.10	3.04
Mysore	3.54	0.81	2.71
Himachal Pradesh	3.39	0.71	2.67
Fair:			
Bihar	2.97	0.71	2.25
Maharashtra	2.93	0.44	2.45
Rajasthan	2.74	2.85	- 0.11
Andhra Pradesh	2.71	0.26	2.45
Madhya Pradesh	2.49	1.28	1.21
Orissa	2.48	0.81	1.66
Low:			
Kerala	2.27	1.30	0.96
West Bengal	1.94	0.59	1.34
Uttar Pradesh	1.66	0.72	0.94
Assam	1.17	1.25	- 0.08
All India	3.01	1.21	1.77

Source: (7).

Table 12.--India: Annual average wholesale price for rice, 1961-66

State	Variety	No. of markets	1961	1962	1963	1964	1965	1966
			Rupees per quintal					
Andhra Pradesh..........	Akkulu	(3)	55.62	54.99	54.39	61.24	[1] 63.07	[1] 65.02
Assam..................	Sali	(3)	51.12	55.65	59.92	66.06	[1] 65.58	[1] 65.14
Bihar..................	Coarse	(5)	55.73	57.74	63.54	70.51	85.08	126.43
Kerala.................	Coarse	(2)	60.91	58.57	60.90	71.20	[1] 63.50	[1] 68.67
Madhya Pradesh..........	Coarse	(3)	41.52	43.92	52.26	58.13	[1] 58.23	[1] 64.80
Madras.................	Medium	(3)	60.24	59.05	57.21	65.33	[1] 66.03	[1] 65.10
Maharashtra............	Coarse	(3)	55.78	52.20	59.74	68.92	[1] 70.05	[1] 69.72
Mysore.................	Coarse	(3)	59.44	59.59	53.53	66.80	89.36	116.60
Orissa.................	Coarse	(4)	39.71	48.86	61.59	61.20	[1] 59.90	76.56
Punjab.................	Coarse	(1)	44.21	44.21	44.21	50.17	[1] 60.00	[1] 60.00
Uttar Pradesh..........	Coarse	(3)	51.51	52.20	54.34	69.16	[1] 65.67	129.09
West Bengal............	Common	(5)	52.77	61.26	77.73	64.05	66.11	[1] 72.00

[1] Statutory controlled prices fixed by State governments (average).

Source: (4), (5), and (6).

Table 13:--India: Annual average wholesale price for wheat, 1961-66

State	Variety	No. of markets	1961	1962	1963	1964	1965	1966
			Rupees per quintal					
Bihar.................	White	(1)	49.59	48.92	49.96	69.30	97.00	107.50
Gujarat................	Red	(1)	51.20	51.02	51.17	62.98	68.99	72.98
Madhya Pradesh.........	White	(3)	36.62	40.28	40.48	56.55	60.57	[1] 60.16
Punjab.................	Coarse	(1)	39.41	42.49	40.34	51.47	58.40	70.88
Rajasthan..............	Coarse	(1)	43.72	41.69	39.38	52.32	51.23	74.14
Uttar Pradesh..........	Red	(1)	38.78	36.09	39.15	65.15	75.21	69.81
	White	(2)	40.09	39.13	41.68	71.00	79.68	78.91
	Dara	(1)	41.86	40.70	42.85	72.08	61.67	79.17

[1] Statutory prices fixed by the State governments (average).

Source: (4), (5), and (6).

Table 14.--India: Projected annual inputs required to achieve an annual compound growth rate in food grain output of 5 percent from 1967-68 to 1970-71[1]

Inputs and production	Unit	1967-68	1968-69	1969-70	1970-71	Annual compound rate of increase 1967-68 to 1970-71
Food grain area.............	1,000 ha.	117,500	118,675	119,885	121,000	1.0
Gross irrigated food grain area............	1,000 ha.	32,000	33,890	35,890	38,000	5.9
High-yield varieties.........	1,000 ha.	6,100	7,900	10,200	13,200	29.5
Fertilizers..................	1,000 tons	1,575	1,880	2,250	2,691	19.5
Food grain production........	1,000 tons	93,624	98,212	103,024	108,000	5.0

[1] The inputs and production for 1968-69 and 1969-70 are interpolations between 1967-68 and 1970-71 (see tables 6 and 7). They should be considered as only general trends to achieve the desired 5-percent annual growth objective discussed in this report.

Table 15.--India: High-yielding varieties program--revised targets for 1967-68 (kharif and rabi/summer)

State	Paddy		Maize		Jowar		Bajra		Wheat		Total	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
	Thousand acres											
Andhra Pradesh...	700	720	65	30	70	116	70	20	--	--	905	886
Assam............	71	7	13	2	--	--	--	--	--	2	84	11
Bihar............	500	[1] 300	200	[1] 220	--	--	--	--	--	[1] 500	700	[1] 1,020
Gujarat..........	160	--	50	8	6	--	300	100	--	314	516	422
Haryana..........	23	--	10	--	--	--	30	--	--	200	63	200
Jammu and Kashmir	100	--	30	--	--	--	10	--	--	20	140	20
Kerala...........	250	500	3	--	--	--	--	--	--	--	253	500
Madhya Pradesh...	50	--	100	[1] 1	95	[1] 10	16	--	--	120	261	[1] 131
Madras...........	800	100	1	9	7	143	21	28	--	--	829	280
Maharashtra......	400	100	150	150	1000	800	300	--	--	200	1850	1,250
Mysore...........	200	[1] 70	50	[1] 45	250	[1] 90	50	1.50	--	[1] 10	550	[1] 216.5
Orissa...........	220	140	12	8	3	0.1	--	--	--	5	235	153.1
Punjab...........	50	--	100	--	--	--	100	--	--	1,000	250	1000
Rajasthan........	2	--	45	--	10	--	80	--	--	125	137	125
Uttar Pradesh....	250	--	325	--	20	--	80	--	--	2,000	675	2,000
West Bengal......	300	75	10	5	--	--	--	--	--	40	310	120
Himachal Pradesh.	20	--	17	--	--	--	--	--	--	20	37	20
Delhi............	[1] 0.5	--	[1] 1	--	--	--	[1] 20	--	--	[1] 5.75	[1] 21.5	[1] 5.75
Goa..............	[1] 25	[1] 5	[1] 0.6	[1] 5	--	[1] 0.2	--	--	--	--	[1] 25.6	[1] 10.20
Pondicherry......	[1] 15	[1] 5	--	--	--	[1] 0.2	--	[1] 0.25	--	--	[1] 15.0	[1] 5.45
Total	4,136.5	2,022	1,182.6	483	1,461	1,159.5	1,077	149.75	--	4,561.75	7,857.1	8,376.00

[1] Provisional.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1968 303-495/52

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

OFFICIAL BUSINESS